Thermal Properties Characterization of Advanced Materials Application to Nanoelectronics

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ABSTRACT

Energy transport is fundamental to both improving our understanding of basic material properties and advancing the intelligent design of new and more optimally functional materials. Energy transport is mediated by various particles and their subsequent interactions, including electrons, photons, phonons, plasmons, spinons, and excitons. The precise nature of any material determines which of these are most important. A more complete understanding of materials currently in development is of critical importance for a wide range of applications ranging from energy harvesting photovoltaics and thermoelectrics to next generation molecular electronics and mechanisms of material failure in nanoelectronics. Currently, there are a number of unanswered questions that are impeding the advancements of many important real-world applications, including the development of green technologies. Our research goal is to answer some of these questions. For example, how does nano-structuring --- such as changes in dimensionality, layering, and nano particle impregnation --- change energy transport characteristics? What effects do chemical and structural modifications on the near-field scale have on far field measurements of energy transport? Is it possible to decouple electronic and thermal transport in materials? What is the source of heat generation in nano electronics systems? The goal of this work deals with the design of materials with more precise and efficient control of energy transport by managing thermal properties of those systems or make them work to our advantage.

Currently, pump-probe spectroscopy is being successfully applied to energy transport measurements using techniques such as picosecond acoustics and time domain thermal reflectance with high temporal resolution [1]. These measurements, however, are limited by the diffraction to half the wavelength light. Quasiparticle excitations such as plasmon- [2] and phonon-polaritons [3,4l] dominate near field, sub-wavelength effects, and high spatial resolution is required to probe them. Scanning-probe microscopy offers high spatial resolution and local probing of near field effects, but is wanting of temporal resolution.

We will present different experimental approaches to measure thermal properties of nano structured materials taking example such as Nano-particles, nano wires, super-lattices, and thin films.

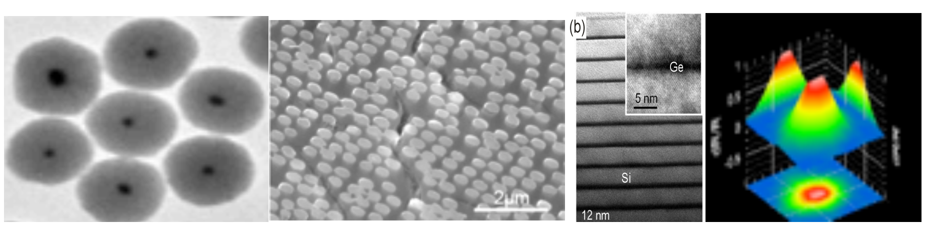

FIGURE 1. Different nano materials, from left to right: Nano particles, nanowires, super-lattice, picosecond snap shot of thermal field upon a nano layer.

REFERENCES

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